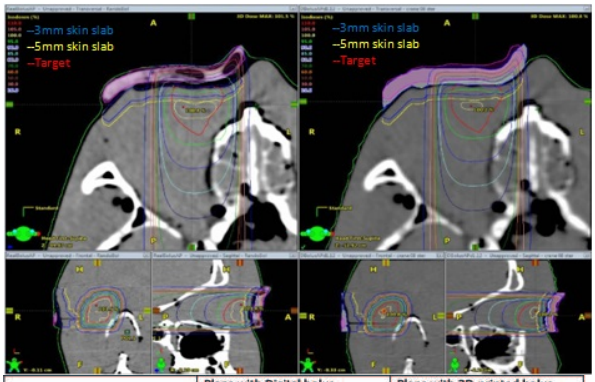

	Plans with Digital bolus	Plans with 3D-printed bolus
Mean ±Standard Deviation dose %		
Target	97±3	99±3
5mm skin slab	46±42	47±43
3mm skin slab	44±42	45±43
Dnear max (%)		
Target	100	101
5mm skin slab	99	100
3mm skin slab	97	98
Volume receiving 95% dose prescription (%)		
Target	83	89
5mm skin slab	14	20
3mm skin slab	7	13

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Differential cross sections measurements for hadrontherapy: 50 MeV/n ^{12}C reactions on H, C, Al, O and ^{nat}Ti targets.

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The increasing interest for hadrontherapy can be attributed to the great accuracy of ion beams to target the tumor while sparing the surrounding healthy tissues (due to the high dose deposition in the Bragg peak and the small angular scattering of ions) as well as the potential biological advantage of ions for some tumor types compared to photons.
To keep the benefits of carbon ions in radiotherapy, a very high accuracy on the dose location is required. The dose deposition is affected by the fragmentation of the incident ions that leads to: (i) the consumption of the projectiles with their penetration depth in the tissues, (ii) the creation of lighter fragments having a different biological effectiveness (RBE), (iii) the apparition of a fragmentation tail after the tumor. The constraints on nuclear models and/or fragmentation cross sections in the energy range used in hadrontherapy (up to 400 MeV/n) are not yet sufficient to reproduce the local dose deposition with the accuracy required in a clinical treatment.
In this context, two experiments with 95 MeV/n ^{12}C beams have been performed by our collaboration in 2011 and 2013 at GANIL [1,2] to measure the energy and angular differential fragmentation cross sections on thin targets of medical interest (H, C, Al, O and ^{nat}Ti). In March 2015, a new experiment with a 50 MeV/n ^{12}C beam on the same targets has been conducted at GANIL. The experimental set-up was made of five three stages telescopes, each composed of two Si detectors and one CsI scintillator mounted on rotating stages to cover angles from 3° to 39°.
The analysis of this new experiment is under completion. It shows that the angular cross sections for light fragments are less forward-focused at 50 MeV/n compared to 95 MeV/n, resulting in "flatter" distributions. As shown in Figure 1, protons and ^{4}He fragments are dominant on the entire angular distribution. At this beam energy, the production of alpha particles is higher than protons for angles up to 20° compared to 10° at 95 MeV/n.
However, at the most forward angles, ^{11}B fragments seem to compete with the protons production.
The energy distributions of the fragments at forward angles are peaked close to the beam energy showing an emission dominated by the quasi-projectile. Comparisons between experimental data and Geant4 simulations using different inelastic models (such as BIC, QMD and INCL++) show important discrepancies.
Final data as well as comparisons with simulations and the previous experiments will be presented during the conference.

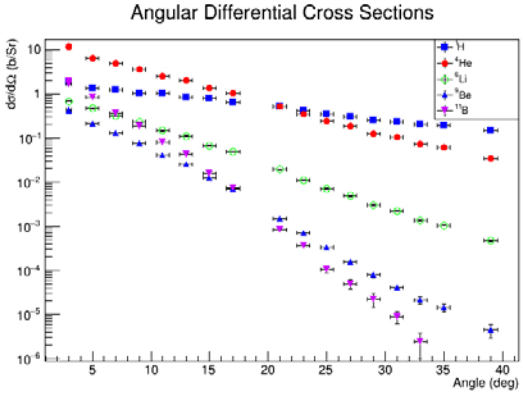

Figure 2: Preliminary angular differential cross section for various isotopes, from Z=1 to Z=5

Keywords: Hadrontherapy, Nuclear-Fragmentation, Cross-Sections

References:
[1] J. Dudouet *et al.* Physical Review C 88, 024606 (2013)
[2] J. Dudouet *et al.* Physical Review C 89, 064615 (2014)

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Correlation of Particle Traversals with Clonogenic Survival Using Cell-Fluorescent Ion Track Hybrid Detector

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Purpose: In radiobiology, the clonogenic survival of cells is considered the gold standard assay for assessment of cellular sensitivity to ionizing radiation. Towards further development of next generation biodosimeters in particle therapy, cell-fluorescent ion track hybrid detector (Cell-FIT-HD) previously engineered by our group [1, 2] was utilized to study its feasibility as a tool for investigating the effects of clinical beams on cellular clonogenic survival.
Materials and methods: Tumor cells were grown on the fluorescent nuclear track detector (FNTD) in cell culture, mimicking the standard procedures for clonogenic assay. Cell-FIT-HD was used to detect the spatial distribution of particle tracks within colony-initiating cells. The physical data were associated to radiation induced foci as surrogates for DNA double strand breakages (DSB), the hallmark of radiation -induced cell lethality. Long-term cell fate was monitored to determine the ability of cells to form colonies.
Results and conclusion: We showed that single cells can attach and grow as colonies on FNTD surface. Usage of the fluorescent and confocal microscopy, together with FNTD technology, enabled simultaneous analysis of the microscopic beam parameters together with the molecular events within colonies, at sub-cellular level. We report the first successful